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XXI.—*A preliminary Study of the Relation between Geographical Distribution and Migration with special reference to the Palæarctic Region.* By Lieut.-Col. R. MEINERTZHAGEN, M.B.O.U.

IN studying the migration of birds we cannot confine ourselves to a narrow view of dates of arrival, weather-influence on migration, routes of migration, etc., but are necessarily compelled to enquire into other ornithological problems which directly influence migration, such as the questions of Moulting, Sustenance on Migration, and others, among which the problem of Geographical Distribution is all-important.

Until quite recently the study of migration was built on a sea of theories, sometimes based on no evidence and at other times based on insufficient data. Many authors had generalized on purely local facts, and attempted to apply to all birds a principle which was only manifest in a single species at some isolated lighthouse or on some island-observatory. The interpretation of facts was often attempted before those facts were themselves accurately known, and opinion was in many cases based not on knowledge, but on conjecture. The result is that many distinguished authors did, and do still, hold opposite views on similar migration-problems.

By applying existing theories to migration in general, it was found that they were usually only applicable to a particular species at one particular spot, and it became apparent that until a fairly comprehensive grasp could be got of the migration of each species throughout its range, we should not progress to any great degree.

The rules governing the migration of a species in Great Britain need not necessarily apply to that same species when passing from its summer quarters in other parts of the world to, say, India or Egypt. Each species contains many communities, and even very small local colonies, whose summer and winter homes and routes of migration are governed by laws which are almost individualistic. Not only each species and subspecies, but every small colony or family of birds presents on occasions a separate problem, the solution of which may differ in accordance with the many varied laws governing the migratory habit. In this connection it is interesting to quote Whitlock ('Migration of Birds,' final paragraph):—

“Every species, nay, every little clan of birds has its own migratory history, resembling as a whole the story of the common flight, but on the other hand differing in many points in its minor details.”

Before, then, the migration of any species can be studied as a whole, a detailed knowledge of its Geographical Distribution will be necessary, and in grappling with this question we are at once confronted with the question of Subspecies or Geographical Representatives.

A Subspecies is an incipient species and is evolved *ab initio* from exactly the same causes as a species. The causes of variation in species or subspecies may be roughly summarized as follows:—We may attribute variation in size to the quantity or quality of food, variation in structure to some essential habit developed in the daily search for food (it is hoped to show at some future date that length of wing is not dependent on length of migration, but on daily habit), special decorative development to courtships necessitating

nuptial display, the thickness or extent of the feathered regions to climate, and variation in colour to climate or local surroundings or food. A high temperature, a dry atmosphere, and a bright light seem to produce that bleached effect usual in desert forms. A temperate climate, moist air, and a dull sky tend to dark plumage. Alpine and Arctic forms display more white than is noticeable in the same bird from farther south or from lower altitudes; though we see in the case of *Corvus cornix capellanus* the brilliant glare of the Persian Gulf having the same effect on plumage as the glare from the Arctic snows has on many northern forms.

It is curious that it is the influence of the breeding-quarters which causes differentiation, the winter-quarters and regions traversed on migration having little effect on coloration or structure. Wide-ranging and common species show the most variation, so long as their breeding-area is not restricted, as in some of the Polar breeding-species. It therefore seems likely that it is the nursery which tends to differentiation. This is most remarkable in such birds as *Cuculus canorus* and *Micropus apus*, whose nursery-life scarcely extends to a quarter of the whole year, and among which several well-marked geographical forms exist which in some cases share a common winter-quarters.

But it seems by no means proved that the breeding-quarters of a species is necessarily its real home, though it is undeniable that the present breeding-quarters of a species produces the homing influence on spring migration. Seebohm (Geogr. Dist. of the Charadriidæ) has already pointed out that it is possible that the present winter-quarters of migratory birds breeding in northern latitudes coincide with the old breeding-quarters of the same bird's ancestors in the Post-Pliocene Glacial Period. It seems probable that a species with a confined breeding-area and an extensive range in winter had its original home in the confined breeding-area to which it is most attached, for this area is much more exact and local in influencing the bird's life, and becomes the focus of its migrations. On the other hand, it may be that a species with a wide breeding-range and a

confined winter-quarters was originally evolved in its present winter-quarters, which retains the hereditary attraction due to the love of a bird for its old home. In this and in other ways geographical distribution, when closely studied, will be found to be most suggestive of a bird's past migratory history.

In this connection it is interesting to note that, though a particular form of bird chooses for its winter-quarters an infinite variety of climate, in most cases the breeding-quarters in the breeding-season show no great variation of climate, though these may cover a vast latitudinal area.

The much-debated question of trinomials is outside the scope of this paper. The value, however, of subspecies to the student of migration is immense, and the more a species can be split into geographical forms the easier becomes its migration problem and the determination of its correct geographical distribution. Throughout the southern part of the Palearctic Region we frequently find more than one form of a single species wintering in the same area, and with the help of subspecific differences, however small or distasteful to the conservative binomial ornithologist, we can at once recognize the breeding-area of the bird in question and its probable migration-route, provided we have reliable information regarding its geographical distribution.

Geographical distribution includes, in the case of migratory birds, the breeding-area, the winter-quarters, and the routes of migration connecting these areas in spring and autumn. Very few species in the Palearctic Region can be classified as true residents throughout all seasons, though many might appear to fulfil the conditions of a resident species until their movements are closely studied. A disregard of the importance of a species' distribution at all seasons has largely discounted the value of many ornithological works and papers, for the mere mention of a species occurring at a certain locality, without date or further detail, does not really advance our knowledge of the geographical distribution of that species, but rather confuses it and encourages misleading deductions.

In writings on the birds collected in a certain area we frequently see a great amount of detailed description of the birds collected, their wing-measurements, etc., and, except for the number of specimens obtained and their sexes, no further detail. A rough guess can be made at the date of collection from the time of year during which the collection was made, but this even is often impossible. There is rarely any indication as to whether the species was common or whether the specimens collected were the only ones observed, whether the bird was resident, on passage, or in winter-quarters. Again, how frequently the major value of a paper is lost by failure to grasp the importance of assigning subspecific value to those specimens which represent geographical races. The occurrence of the Song-Thrush in Portugal is of little value without knowledge as to whether the bird is of the British or Continental race; or, again, the passage of the Redstart in Egypt or Palestine loses its importance without a determination of its subspecific rank, which alone helps us in studying the bird's distribution and migration.

It is perhaps ungenerous thus to criticise the great efforts made by Field and Museum Naturalists, but the writer himself being an offender in this respect, reference is made to this most important point in the hopes of stimulating further effort to gain the maximum results from the slaughter of such beautiful creatures as birds, to enable us to interpret correctly the many and varied facts with which Nature presents us, and to solve the complex problems of distribution and migration. No killing of birds can be justified merely to compile a list of species obtained in a certain locality. Careful field-notes by the collector and an accurate determination of subspecific rank (where this exists) by the man who works out the collection can alone justify its formation. A mere list of birds likely to be found in almost any part of the world could be compiled by any studious ornithologist in the library of the Zoological Society in Regent's Park, without a visit to the locality in question and without taking the life of a single bird.

Neither are we dealing with a science which is stationary.

Geographical distribution and migration have been in the past, are now, and always will be fluctuating, sometimes imperceptibly, sometimes by leaps and bounds. The same applies to the geographical races of a species. As distribution and migration alter, so do subspecies become evolved, usually very gradually, but sometimes within the lifetime of man. But the problems remain constant, and the laws which govern these problems change but little.

The extent of the geographical distribution or range of a species, on which largely hinges the differentiation in both species and subspecies, is due to :—

1. Gradual expansion or contraction.
2. Periodic and regular migration.
3. Sporadic migration, invasion, or extensive wanderings.
4. Human agency, direct or indirect.

A few cases will be taken to illustrate these problems which so closely link Distribution, Migration, and Differentiation among birds.

1. *Gradual expansion or contraction.*

Birds have been known to gradually extend their range into every point of the compass, and it will probably be found that normal expansion radiates from the bird's original home. It is interesting to note that the Charadriidæ are believed by Seebohm to have originated in the north, and the Swallows have been credited with an early home not far removed from the tropics.

But it is more recent and current movement which now concerns us.

An example of gradual expansion to the south is well illustrated by the range of the Crested Lark (*Galerida cristata* and its subspecies), whose original home was probably central and western Asia. This species has now amplified its distribution from France to Corea, and south to Sierra Leone and Senegambia on the west coast of Africa and Abyssinia and Somaliland on the east coast, and to Ceylon. It would appear from an examination of this

distribution that expansion has followed coast-lines, which, as pointed out by Hartert (Novit. Zool. xx. 1913, p. 76), is a tendency not only among migratory but among such sedentary species as the White Owl, Chough, Cirl-Bunting, and others. But here, in the case of *Galerida cristata*, we see expansion and differentiation progressing concurrently; and there can be little doubt that the Crested Lark, a hardy species capable of residence in the snows of central Europe and Asia or in the heat of the Red Sea littoral, will not check its expansion till the Cape Seas arrest its progress. Its advent on the west coast of Europe is probably of comparative recent date, for it has never established itself in Great Britain, though there can be little doubt it would have done so during the last century if its efforts had not been checked by the greed for rare birds.

The Shore-Lark (*Eremophila alpestris flava*), which in comparatively recent times has become a common breeding-species in Arctic Norway, affords a good illustration of gradual expansion to the west. At the same time as expansion of breeding-range, these birds opened out a new line of migration about 1847 (Gaetke) and became a common bird of passage at Heligoland in spring and autumn. This fact is of particular interest, as other northern species (*Phylloscopus borealis borealis*, *Anthus gustavi*, and *Emberiza pusilla*) have, in spite of westward extension of their breeding-range, rigidly adhered to their ancient migration-route and winter-quarters in south-east Asia. Cooke ('Migration of Birds,' p. 6) further illustrates the phenomenon of westward extension in the Bobolink, which species rigidly adhered to its ancient migration-route though adding 1000 miles to its line of flight.

Gradual expansion to the north can be found in the case of the Greater Spotted Woodpecker in Great Britain and in the case of *Passer moabiticus moabiticus*. This latter bird, formerly confined to the south end of the Dead Sea, is now commonly found in the Jordan Valley at the north end of the Dead Sea and will doubtless extend to Galilee.

Eastward expansion, though the example must be taken

from outside the Palearctic Region, is well illustrated by the Grey Parrot in Equatorial Africa. This bird, formerly unknown much east of Uganda, has rapidly extended its range across the Mau Plateau and Rift Valley, and will ere long find itself on Mount Kenya and thence to the east coast of Africa.

Gradual contraction of range from natural causes may be due to meteorological or climatic conditions. Gaetke ('Birds of Heligoland') quotes the erosion of the Heligoland cliffs as partly destroying the breeding-haunts of the Guillemot and Razorbill. A cyclone in Mauritius almost exterminated the local species of Martin. The sudden rising of water on an artificial lake in Baluchistan completely destroyed many dozens of nests of a Grebe, together with many hundreds of their eggs, and the whole colony of breeding-birds moved that night and have not since returned to that lake as a breeding-species.

Or contraction may be due to inability to establish a migratory habit, which we see after severe winters among some of our own resident forms; or to an insufficiently developed migratory habit, as with certain communities of Redwings, Fieldfares, and Starlings, who perish in the south of England and Ireland in very severe weather rather than continue their passage to south-western Europe, as do other communities of the same species who have developed an increased migratory line of flight.

Or contraction may be due to expansion in range of some other species which becomes an evicting factor. The Jackdaw is believed to have been largely responsible for driving the Chough from the cliffs of southern and western England. The House-Sparrow, in extending its range in Russian Turkestan, has supplanted the Tree-Sparrow, and has evicted the House- and Sand-Martin from many nesting-haunts in England. The Puffin has replaced the Manx Shearwater in some of the islands of the Inner Hebrides.

Food-supply will also contract the range of a species, though this is usually only a temporary inconvenience.

Gradual contraction among non-migratory species will eventually produce interrupted distribution, extermination, or isolation. Of the first of these conditions *Sitta canadensis* occurring in Corsica, China, and America, *Cyanopica cyaneus* in Spain and Eastern Asia, and *Pyrhocorax pyrhocorax* with its reported isolated colony in Abyssinia, afford good examples.

Isolation will in its turn most assuredly produce differentiation. In these three above-quoted cases, there can be little doubt that the isolated colonies emanated from the same parental stock and that they primarily emigrated from the same area. As in Mesopotamia we find derelict remains of ancient civilization, such as the banks of some Babylonian canal, cropping up at sometimes great intervals and only giving us a general clue to a once-huge work, so we find among some species, derelict groups or forms cropping up in widely-separated parts of the world as landmarks of some bygone migration or continuous distribution.

Such gradual movements as are outlined above, when undertaken by what are commonly believed to be resident species, represent in fact incipient migration or movements from which a strong migratory habit has since developed in other species.

2. *Periodic and regular migration.*

We see periodic and regular migration effecting changes in breeding-area in certain species of Palearctic birds. We find the Bee-eater (*Merops apiaster*) taking advantage of South African conditions and establishing breeding-colonies there (Stark and Selater, 'Fauna of South Africa, Birds,' iii. p. 59). That this species breeds regularly in Algeria and Egypt is beyond question, and it seems possible that it also breeds in the northern Sahara (Novit. Zool. xviii. 1911, p. 524, xx. 1913, p. 60). It is not then surprising to find them nesting in South Africa, where conditions are more favourable than in North Africa. But it is not inferred that this bird breeds twice a year, once in its normal summer haunts and again in its winter haunts. It is more likely that the

colonies which breed in South Africa are resident communities who have dropped the migratory habit as redundant to their life.

Again, we find the Sandpiper (*Totanus hypoleucus*) nesting in tropical East Africa (Van Someren), and the writer observed the young of this species with their parents on the Kajiado River near Nairobi in 1915. The Pratincole is reported to have bred in a colony near Durban in November 1917 (Ibis, 1908, p. 385), Geoffroy's Sand-Plover is suspected of breeding in Somaliland (Areher) and the Swallow (*Hirundo r. rustica*) in Uganda and on Kilimanjaro.

It is held that these cases of expansion of the breeding-range are directly attributable to migration, as they all occur among species in which the migratory instinct is strongly developed. Whether or no these instances are cases of incipient isolation remains to be seen. If this is the case, we shall get differentiation, as in the case of *Corvus cornix*, the Hooded Crow, which has two communities, in Egypt and on the Persian Gulf, both of which have lost the migratory habit, and one of which has assumed considerable differentiation.

It has been stated (Eagle Clark, 'Migration of Birds,' i. pp. 15-17) that southern tropical regions are not suited as a nursery for the hardy northern birds, and if breeding were attempted in such regions the species would become extinct.

Facts do not entirely support this view, though doubtless it is true as a broad principle. We have already referred to the Hooded Crow, an essentially hardy northern species and one of the few birds remaining in Arctic Norway in winter, as breeding under one form (*Corvus capellanus*) on the shores of the Persian Gulf, one of the hottest parts of the world and eclipsing the heat of any part of tropical Africa, while yet another undifferentiated form is resident in Egypt and northern Sinai. We find a Swallow (*Hirundo saviinii*) breeding in Egypt, various forms of the White Owl and Kestrel throughout the tropics of Asia and Africa, and other birds such as *Saxicola torquata*, the Stonechat, with geographical races equally at home from the Arctic Regions to Cape Town.

All such distribution, as illustrated in this last paragraph, is due either to gradual emigration or to a regular migratory habit at some remote period, and has depended for its success on the initial capacity of a species to adapt itself to new surroundings, which was possibly a case of necessity in the earliest attempt.

In this connection it would be interesting to ascertain whether the same species, when nesting in tropical countries, lays fewer eggs in the clutch and rears more broods in the season than the same bird in more northern climes. The Blackbird is said (Chapman, 'Wild Spain') to lay but three eggs in Spain, to raise three broods in Tangier (Favier), whilst in the Canaries the local Blackbird (*Turdus m. cabreræ*) lays very few eggs in the clutch (Ibis, 1912, p. 597). The Wren (*Troglodytes*), a prolific breeder in northern climes, appears to lay but four eggs in the normal clutch in Sicily (Ibis, 1912, p. 171). Is such the case among other species which have tropical representatives? The point is submitted to the many distinguished zoologists whose vast collections might help to solve the problem. Is the normal clutch regulated by the capacity of the parents to feed the young (or water the young, in the case of Sand-Grouse), or by the limits of brooding-surface on the parent's abdomen, or by the normal mortality in the species, or by what? Even such questions have influence on migration and distribution, for it is by no means certain whether birds go to the Arctic Regions for reproduction, on account of their ancient love for home, or to enable them to get sufficiently long days to collect a satisfactory supply of food for their offspring, or whether merely because the Arctic Regions offer a more prolific food-supply than more southern regions. If either of the two latter causes are correct, we should expect to find the Charadriidæ and Anatidæ which breed in the tropics to lay fewer eggs in the clutch than those which breed in northern Europe. We know that a plethora of food reflects itself on reproduction (*cf.* Snowy Owls and Rough-legged Buzzards in Lemming-years in Scandinavia, and the increase of Hyænas after wholesale deaths among natives in East Africa).

3. *Sporadic migration, invasion, or extensive wanderings.*

The well-known invasions of *Syrrhaptes* need no comment. That they would lead to eventual permanent colonization is almost certain, but so far the species has never had a fair chance. There is no reason, however, why the wide distributions of *Pterocles arenarius* or *P. senegallus* should not have been initiated by colonization after sudden invasion, for the Sand-Grouse as a group are essentially wanderers in search of suitable and rather specialized food, seeming to pride themselves on erratic movement and ignoring any seasonal lines of flight, which, generally speaking, constitutes migration; though in some spots they are particularly regular on migration, as is the case with *P. arenarius* of northern India.

The Rose-coloured Starling, aptly described as a veritable gipsy among birds, gives us a further illustration of colonization (in Italy and elsewhere) after invasion; and the various subspecific colonies of the Crossbill (*Loxia curvirostra*) in the Mediterranean region might equally be due to colonization after irruption at some remote date, as opposed to either gradual expansion or regular migration, though the accuracy of such a theory to account for their present distribution is by no means certain.

4. *Human agency, direct or indirect.*

The introduction of such species as the Pheasant, Goldfinch, and Starling to various parts of the world will suffice to illustrate expansion of range due to direct human agency. In the case of the Goldfinch, we find in the Bermudas that the bird has already established for itself a differentiation entitling it to subspecific rank. In the case of the introduction of the Starling to Cape Town, it is interesting to note that the species has abandoned the migratory habit and has become a pure resident, not even congregating into flocks in winter.

Contraction of distribution under this heading is the sad story of extermination, being generally confined to species

having a very local breeding-area, such as the Passenger-Pigeon, Esquimaux Curlew, and Labrador Duck, or to species which, having a large range, are unable to resist slaughter at all seasons. Systematic egg-stealing under the cloak of science, but which in reality is the travesty of science, is also responsible for such contraction of range, as in the case of so many birds which have within the last century ceased to be included among British breeding-species.

Indirect human agency has increased the breeding-range of certain species, though only in a minor degree. The re-afforestation of land and artificial sheets of water have, no doubt, helped in this manner, though in most cases it has been a case of re-establishment. The carrying of migratory birds on ships comes under this heading.

In like manner has interference with terrain, such as the draining of the Fens, contracted the breeding-range of birds. The introduction of a destructive element has had similar effect, as in the case of the arrival of the pig in Mauritius which completed the sad fate of the Dodo, or the great mortality among sea-birds from the torpedoing of a tank-steamer and the resultant film of oil spread over vast areas of sea.

From these examples it will readily be seen how closely related are migration, distribution, and differentiation among birds. Without the framework of distribution the study of migration can only lead to theory. Each separate species or subspecies must be studied, if possible throughout its range, and then we shall arrive at facts from which the whole narrative of migration can be read. No two species which have a similar geographical distribution are known to have similar migratory habits. We even get, among birds of the same species, vast differences in migratory habit, hence the great importance of detailed study.

The task is gigantic, and though no one human life can hope to complete the work, a combined effort by all field-naturalists and collectors, with the very great assistance supplied by the various organizations in Britain, America,

and on the Continent for the study of local movement, not to mention that most valuable of all schemes—the “ringing” of birds,—will go far to building up an edifice grounded on solid facts, whose completion we must leave to future generations of enthusiasts.

Finally, it must be clear to any reader of this rather fragmentary paper that no exhaustive or complete study of the subject has been attempted. Many points connected with the relation between distribution and migration have been merely suggested, in the hopes that such preliminary mention will stimulate ideas on this, the most attractive phase of an absorbing science.

XXII.—*On Birds from South Annam and Cochin China.*

Part I. PHASIANIDÆ—CAMPOPHAGIDÆ. By HERBERT C. ROBINSON, M.B.O.U., and C. BODEN KLOSS, M.B.O.U.

(Plates VII.—XI. & Text-figure 3.)

Narrative of the Journey.

By C. BODEN KLOSS.

It is now several years ago since I determined some day to pay a visit to the Langbian region in French Indo-China, partly because it is evidently a most attractive country, little known to English travellers, and partly because there is to be found there that mountain-area, still zoologically unexplored, which is most remote from the fairly well-known upland regions of Burma and Yunnan. I hoped, as the few specimens secured by Mrs. Vassal seemed to indicate and as has proved to be the case, that a rich harvest of novelties would be obtained by the first serious zoological explorer. Early in 1918 my opportunity came with three months' local leave.

The Langbian Plateau (text-figure 3) is situated in southern Annam, and Dalat, the little settlement at its southern side, is about 45 miles distant from Phaurang, a coast town of some local importance in lat. $11^{\circ} 35' N.$, $51^{\circ} W.$